

Revisions to Lighting Power  
Allowances, Complete Building  
Method and Area Category Method

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BENYA LIGHTING DESIGN

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## Revisions to Lighting Power Allowances, Complete Building Method and Area Category Method

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- Eley Associates
- CEC Staff Members

Task: Revise Lighting Power

Allowances

Complete Building Method

- Table 1-M of §146 contains the allowed lighting power density values for complete buildings
- Task: add space types
- Task: update allowed LPD for all listed space types
- Task: revise Table 1-M

Task: Revise Lighting Power

Allowances

Area Category Method

- Table 1-N of §146 contains the allowed lighting power density values for area categories
- Task: add space types
- Task: update allowed LPD for all listed space types
- Task: Revise Table 1-N

### How to Determine the Space Types to Add

- Primary process: examine other energy codes to discover other space types.
  - ASHRAE/IESNA 90.1-1999
  - Oregon Energy Code
  - Washington and Seattle Energy Codes
- Determine whether the space adds a usable new space type that is covered by the legal scope of Title 24
- Discuss space types with CEC staff and choose based on consensus

## Space Type Determinations

- Table 1-M (whole building) Hotel Added
- Table 1-N (area categories)
  - Civic facilities
  - Housing, Public and Commons Areas
    - Multi-family
    - Dormitory, Senior Housing
  - Prisoner holding cell or jail
  - Police or fire stations
  - Post office
  - Transportation facilities

### Definitions Added

**Civic Facilities** include areas within government buildings that are not offices, corridors, rest rooms, or any other specific category in Table 1-N. Civic facilities include, but are not limited to, waiting rooms, jury rooms, courtrooms, hearing rooms, council or board rooms, council chambers (except offices), and civic lobbies.

## Definitions Added

Housing, Public and Commons Areas are areas within housing facilities as follows:

- In multi-family housing, these areas include hallways, lobbies, commons areas such as community rooms, exercise and recreation spaces, and other common spaces of the building except offices, stairwells, kitchens, dining rooms, toilet rooms, locker rooms, storage rooms, or mechanical rooms.



## Definitions Added

■ In multi-family housing specifically designed for seniors, these areas include community rooms, dining rooms, multipurpose rooms, reading rooms, corridors, exercise and recreation rooms, and other spaces of the building except offices, kitchens, libraries, toilet rooms, locker rooms, storage rooms, or mechanical rooms. In order to qualify as senior multifamily housing, the project shall include three or more of the following facilities: skilled nursing, assisted living, Alzheimer's care, hospice, common dining. Skilled nursing means having facilities equipped to provide medical care to non-ambulatory residents and meeting California law ..... Assisted living means having facilities to provide limited medical care and assistance to disabled and/or non ambulatory residents and meeting California Law..... Alzheimer's care means providing secured facilities specifically designed for the care and protection of persons suffering from Alzheimer's and dementia meeting California law.... Hospice means having facilities to provide limited medical care for the terminally ill in a residential setting meeting California Law... Common dining means providing a community cafeteria or dining facility for residents and guests.

### Definitions Added

- In dormitories, these areas shall include community rooms, dining rooms, multipurpose rooms, reading rooms, corridors, exercise and recreation rooms, and other spaces of the building except offices, libraries, toilet rooms, kitchens, locker rooms, storage rooms, or mechanical rooms.

### Definitions Added

**Prisoner holding cell or jail** includes incarceration spaces, lockups, jails, and related support spaces such as prisoner interview rooms.

## Definitions Added

- **Police or fire stations** includes conditioned garages and maintenance areas for emergency vehicles and equipment; common meeting and training rooms, lobby and receiving areas, waiting areas, hearing rooms, and spaces of the building except offices, libraries, toilet rooms, kitchens, locker rooms, storage rooms, or mechanical rooms.

### Definitions Added

- **Post office** includes the areas within a building in which the US Postal service receives, sorts, dispenses or otherwise services mail, including public waiting, counter service and self service areas.

## Definitions Added

- **Transportation facilities** includes areas within airport, bus, passenger rail, mass transit, or passenger liner terminals or concourses such as lobbies, ticketing, baggage claim, holdrooms, information and help areas, and related facilities. except dining rooms, retail, offices, libraries, toilet rooms, kitchens, locker rooms, storage rooms, or mechanical rooms. If freestanding with a transportation facility, a specific use type e.g. retail or dining shall be permitted to be determined as if it were enclosed by a ceiling high partition or demising wall..

## Process: Revising Allowed Lighting Power Density Values

- Determine technology improvements or other changes in lighting since 1995 and 1998 that may permit less power use
- Determine cost effectiveness of such technology
- Determine facilities to which such technology is applicable
- Run lumen model and confirm

### Technology Improvements Affecting Power Density

- The T-8 Second Generation “Super” Fluorescent Lamp
- Innovative New Lighting Systems Employing the T-5HO Lamp
- The Metal Halide Pulse Start Lamp
- The Ceramic Metal Halide (CMH) Lamp



## The T-8 Second Generation "Super" Fluorescent Lamp Enhancements

- ❑ Premium construction of cathode assembly designed for extended lamp life
- ❑ Use of "barrier coat" phosphor which returns unused UV radiation into the lamp and reduces lamp lumen depreciation
- ❑ Use of optimized high CRI phosphor
- ❑ Availability of "low power" lamps (30 nominal watts versus 32 standard)

<b>Lamp</b>	<b>Maker</b>	<b>Initial Lumens</b>	<b>Initial LPW*</b>	<b>Percent of Base</b>	<b>Mean Lumens</b>	<b>Mean LPW*</b>	<b>Percent of Base</b>	<b>Lamp Life, Hrs</b>
<i>Standard Lamps</i>								
F32T8/7xx	Generic	2850	83	97%	2508	73	97%	20,000
F32T8/8xx ** (base)	Generic	2950	86	100%	2596	75	100%	20,000
<i>2nd Generation Lamps</i>								
F32T8/841/XP	Sylvania	3150	91	107%	2993	87	115%	24,000
F32T8/ADV8xx/ALTO	Philips	3200	93	108%	3040	88	117%	24,000
F32T8XL//IS/WM/SPxx	GE	2850	97	113%	2675	91	121%	25,000

## Innovative New Lighting Systems Employing the T-5HO Lamp

- Replacing metal halide in medium and high bay applications
- Permits lower lighting power and multi-level switching at high efficacy

<i>Lamp Type</i>	<i>Lumens per lamp</i>	<i>Lamps per luminaire</i>	<i>Mean Lumens per Lamp</i>	<i>Total Mean Lumens per Luminaire</i>	<i>CU</i>	<i>Per 10000 SF Luminaires per 50 fc</i>	<i>Input watts per luminaire</i>	<i>Watts/SF</i>
MH400 base	40000	1	26000	26000	0.82	24	458	1.10
MH400PS	42000	1	31000	31000	0.82	20	425	0.85
MH400PS	42000	1	31000	31000	0.82	20	452	0.90
F54T5HO	5000	6	4500	27000	0.83	22	360	0.79

## The Metal Halide Pulse Start Lamp

- Higher initial lumens per watt
- Better lumen maintenance

<b>Lamp Watts</b>	<b>Initial Lumens</b>		<b>Mean Lumens</b>		<b>Mean LPW</b>		<b>Life</b>		<b>Pulse Power</b>
	Probe	Pulse	Probe	Pulse	Probe	Pulse	Probe	Pulse	<b>Needed</b>
175	13600	17000	8800	12500	43	61	10,000	15000	70%
250	20800	23000	13500	17000	46	58	10,000	20000	79%
400	36000	41000	23500	31000	52	69	20,000	20000*	76%

### The Ceramic Metal Halide (CMH ) Lamp

- Color and performance similar to Halogen Infrared Reflecting
- Low wattage lamps suited for retail and general use

<i>Lamp</i>	<i>Life, hours</i>	<i>CBCP, initial</i>	<i>Lumens, initial</i>	<i>MBCP</i>	<i>Lumens, mean</i>	<i>Input watts</i>	<i>MLPW</i>	<i>Mean MBCP/ watt</i>
100PAR/HIR/FL (GE)	3000	6300	2200	5985	2090	100	21	60
CDM35PAR30L/M/FL (Philips)	10000	7400	2000	5920	1600	45	36	132

## Life Cycle Cost (LCC) Tests

- The key points of the annual LCC methodology are as follows:
  - 1. If a measure reduces overall life cycle cost, then it is cost effective. It is not necessary (or even desirable) to calculate absolute life cycle cost.
  - 2. The change in life cycle cost between two measures is calculated as follows:
    - $\text{Change in Life cycle Cost} = \text{Change in Initial Cost} - \text{Present Value of Electricity Cost Savings} - \text{Present Value of Gas Cost Savings}$
  - 3. The present value of electricity and gas cost savings is calculated as follows
- $\text{Present Value of Energy Cost Savings} = \text{Energy Saved Per Year} \times \text{Present value per unit of energy saved over the life of the measure}$

## Test Results

In all technology advances, the LCC method results in a life cycle cost advantage

- The Second Generation T-8 and Pulse Start Metal Halide are profoundly cost beneficial
  - Very small incremental cost
  - Rapid return on investment suggests making the technologies mandatory
- The T-5HO and Ceramic Metal Halide are cost effective enough to use as standards setting data

## Lumen Method Modeling

- Used by Title 24 and ASHRAE/IESNA 90.1
- Employs the Lumen Method to determine an appropriate theoretical minimum lighting power density
- The Lumen Method

$$E = \frac{\text{Lumens} \times \text{Light Loss Factors} \times \text{Coefficient of Utilization}}{\text{Area of space}}$$

- Model Spreadsheets Determinations
- a footcandle levels for task, ambient and other lighting requirements
  - light source(s) suitable for the application (up to 3)
  - suitable luminaire for each source
  - a representative space geometry and RCR
  - a CU and light loss factor for each luminaire



## Calculations

- Weighted average illumination level  $E_{avg}$  based on percentage of space
- Weighted average lumen and power contribution from each luminaire
- Final result: theoretical minimum lighting power needed to light the representative space
- Adjustment: round up to the next highest tenth of a watt per square foot (at least 5%) to address “real world” conditions

### Sample spreadsheet

Space Type	Auditorium	Whole Building	1998 Area LPD	2.0
Length	60		1998 Bldg LPD	1.8
Width	40		Ratio	1.1
Height	20		2003 Area LPD	1.7
Same as 1998	yes		2003 Bldg LPD	1.5
Finishes	70/50/20	3 Light Loss Factor		0.80

Light Level	Footcandles	% of space
Task	30	100
Ambient		
Other		

Lighting System	#1	#2	#3	
Lamp	Halogen IR	Compact Fluore	T8/T5	
Luminaire	Direct	Diffuse	Indirect	
Source Code	3	4	6	
RCR	3.65			
Percent of Total	33	33	34	100
CU of Fixture	0.90	0.45	0.35	
Note/Source	Downlight	Sconce	Cove/uplight	

Calculations	
Average FC	30
Total Net Lumens:	72,000
Net Lumens #1	23,760
Net Lumens #2	23,760
Net Lumens #3	24,480
Lamp Lumens #1	33,000
Lamp Lumens #2	66,000
Lamp Lumens #3	87,429
Gross lumens #1	26,400
Gross lumens #2	52,800
Gross lumens #3	69,943
Lamp watts #1	1,650
Lamp watts #2	1,200
Lamp watts #3	971

Minimum Theoretical Watts	3,821
Minimum Theoretical Power Density	1.58
Recommended Value for Standard	1.70

With Chandelier Allowance

Data Used in Calculations	
Lamp Types	MLPW
1 Incandescent	10
2 Halogen	15
3 Halogen IR	20
4 Compact Fluorescent	55
5 Biax/T5HO	75
6 T8/T5	90
7 Ceramic Metal Halide	50
8 Pulse start metal halide	75
9 Other	70
Finishes	Fixture Types
80/70/20	Direct
80/50/20	Semi-direct
70/50/20	Direct-indirect
70/30/20	Semi-indirect
50/50/20	Indirect
30/30/20	Diffuse
	Directional

### Table 1-M Changes

<i>Building Type</i>	<i>Current</i>	<i>Proposed</i>
High bay industrial	1.2	1.1
Hotel	New	1.7
Medical Buildings and Clinics	1.2	1.0
Office Buildings	1.2	1.1
Religious Facilities	1.8	1.6
Convention Centers	1.4	1.3

### Table 1-M Changes

<i>Building Type</i>	<i>Current</i>	<i>Proposed</i>
Retail and wholesale	1.7	1.5
Schools	1.4	1.2

Table 1-N Changes

<i>Space</i>	<i>Current</i>	<i>Proposed</i>
Auditorium	2.0	1.7
Auto Repair	1.2	1.1
Bank	1.4*	1.2*
Civic Facilities	New	1.4*
Classrooms	1.6	1.2

### Table 1-N Changes

<i>Space</i>	<i>Current</i>	<i>Proposed</i>
Convention Conference	1.5*	1.4*
Electrical and mechanical rooms	0.7	0.6
High Bay Industrial	1.2	1.1
Precision Industrial	1.5	1.3
Multi-family housing commons	New	1.0

Table 1-N Changes

<i>Space</i>	<i>Current</i>	<i>Proposed</i>
Dormitory, senior housing	New	1.5
Hotel function	2.2*	2.0*
Kitchen, Food Prep	1.7	1.6
Malls Arcades Atria	1.4*	1.2
Medical and Clinical Care	1.4	1.2

Table 1-N Changes

<i>Space</i>	<i>Current</i>	<i>Proposed</i>
Office	1.3	1.2
Jail	New	1.0
Police or fire station	New	1.3
Post office	New	1.6
Religious Worship	2.0*	1.9*



### Table 1-N Changes

<i>Space</i>	<i>Current</i>	<i>Proposed</i>
Retail sales	2.0	1.8
Transportation Facilities	New	1.2

### Summary

- 10-15% reductions to a number of values due to new technology
- Little or no impact to spaces where tungsten sources play an important role